CULTURE AND COSMOS

A Journal of the History of Astrology and Cultural Astronomy

Vol. 4 no 1, Spring/Summer 2000

Published by Culture and Cosmos
and the Sophia Centre Press,
in partnership with the University of Wales Trinity Saint David,
in association with the Sophia Centre for the Study of Cosmology in Culture,
University of Wales Trinity Saint David,
Faculty of Humanities and the Performing Arts
Lampeter, Ceredigion, Wales, SA48 7ED, UK.

www.cultureandcosmos.org

Cite this paper as: Edgar Laird, 'Heaven and the *Sphaera Mundi* in the Middle Ages', *Culture and Cosmos*, Vol. 4 no 1, Spring/Summer 2000, pp. 10-35.

British Library Cataloguing in Publication Data
A catalogue card for this book is available from the British Library

ISSN 1368-6534

Printed in Great Britain by Lightning Source

Heaven and the *Sphaera Mundi* in the Middle Ages

Edgar Laird

Abstract. This paper examines the development of the idea of heaven in relation to the *sphaera mundi* – the sphere of the world - in medieval literature. The *sphaera mundi* is a model of the cosmos that at its most elementary is very simple indeed. At the centre of it is the earth, so small as to be virtually a dot in comparison to the whole or even to the smallest star. Earth is surrounded by the sea, which in turn is surrounded by air, as also air is surrounded by fire. Surrounding the fire is a sphere that 'bears' the moon, and around that sphere are others, like layers of an onion, bearing the other planets: Mercury, then Venus, the sun, Mars, Jupiter and Saturn. Then come the sphere bearing the fixed stars and, beyond it, one or more others. All these spheres together constitute the sphere of the world.

I

This conception of the *sphaera mundi*, with substantial variations in detail, was enormously durable, its history extending, according to some authors, from remotest antiquity[1] through the Middle Ages to the time of Copernicus and even beyond. The oldest surviving textbook on it is the *Sphaerica* of Theodosius (second century B.C.), which appears to be based on earlier textbooks now lost.[2] As conceived in that work, the sphere survives little altered in John of Sacrobosco's early-thirteenth-century textbook, the *Tractatus de sphera*, in which Theodosius is cited by name; and a copy of Sacrobosco's work, in a fifteenth-century printed edition, found its way into the library of Thomas Jefferson.[3] Between Theodosius and Sacrobosco the model was re-rendered by Macrobius, Martianus Capella, Isidore of Seville, Bernardus Silvestris, and Alan of Lille, among others.[4] In the thirteenth and fourteenth centuries it was intensely studied in Sacrobosco's treatise in the schools and was represented and re-conceived so often and so intently – in other treatises and in poems, diagrams, physical models, and university lectures and commentaries – that a large accretion of ideas gathered about it and it

Edgar Laird, 'Heaven and the *Sphaera Mundi* in the Middle Ages', *Culture and Cosmos*, Vol. 4 no 1, Spring/Summer 2000, pp. 10-35.

took on an autonomous existence as an object of study independent of any particular text.

As an object of study, it could be seen from various points of view, the chief ones being the three provided by the Aristotelian division of speculative sciences into physics, mathematics, and theology or metaphysics.[5] Our present interest is in the way in which spherists attempt to look beyond the sphere of the world toward heaven, an attempt made appropriately enough from the theological or metaphysical points of view. It is necessary, however, for us to see also how physics and mathematics view the sphere, for as Martianus tells us, mathematics does not disdain to give heed to physical philosphers;[6] and as Thomas Aquinas says, metaphysics, which is the highest science, makes use of those things that are proved in other sciences.[7] Boethius (480-524) transmits the division of sciences to the Middle Ages as follows:[8]

> Physics *[naturalis*] deals with motion and is not abstract or separable….for it is concerned with forms of bodies together with their constituent matter, which forms cannot be separated in reality from their bodies.
>
> Mathematics [*mathematica*] does not deal with motion and is not abstract, for it investigates forms of bodies apart from matter and therefore apart from motion; which forms, however, being connected with matter cannot be really separated from bodies.
>
> Theology [*theologica*] does not deal with motion and is abstract and separable, for the Divine Substance is without either matter or motion.

The differences between the physical and mathematical representations of the sphere can be explained briefly here because they have already been described in great detail by Pierre Duhem and others.[9] The Middle Ages inherited and maintained two distinct and sometimes opposing tendencies in the study of the cosmos. On the one hand is the work of physical cosmologists (whom Duhem calls *physiciens*), and on the other is that of mathematical astronomers (Duhem's *astronomes*). In summary, one may characterise the physicists as Aristotelian and the mathematical astronomers as Ptolemaic, on the ground that physicists, like Aristotle, regard all celestial spheres as having the same centre, whereas astronomers, like Ptolemy, posit eccentrics and epicycles. The difference, which is fundamental, is succinctly stated by the thirteenth-century commentator on Sacrobosco, Robertus Anglicus: physicists (*'naturales'*)

suppose that all of the spheres are concentric; astronomers (*'mathematici')* do not.[10]

The two approaches are differently motivated, and different consequences follow from them. The physicists are concerned to produce a coherent cosmological system; the astronomers are more intent on working from a mathematical base to make accurate predictions of celestial motion.[11] Each of the two approaches had its own kind of rightness, but they were partly in conflict with one another, as Moses Maimonides (1135-1204) clearly saw. The rightness of Ptolemaic principles, he says, is attested by the correctness of calculations from them concerning eclipses; but assuming that Aristotelian physics is right, how can one imagine a rolling motion in the heavens or a motion around a centre that is not immobile? 'This', says Maimonides, 'is the true perplexity'.[12] There is an obvious temptation to seek a resolution by looking to a science higher than either physics or mathematics. But Maimonides says that of the heavens human beings grasp nothing beyond the physical and a small measure of the mathematical, and he concludes, 'I shall accordingly say in the manner of the poetical preciousness*: The heavens are the heavens of the Lord, but the earth hath He given to the sons of man*'.[13]

Physics was not, of course, completely distinct from mathematics.[14] Physical cosmologists did employ mathematics, often taking note of eccentrics and epicycles, and mathematical astronomers did imagine a physical structure of the cosmos. Robert Grosseteste (d. 1256) sometimes employs Ptolemaic eccentrics and sometimes assumes an Aristotelian arrangement of concentric spheres. Perhaps, as has been suggested, he followed Ptolemy when he wished to do astronomy and Aristotle when he desired a physical basis for metaphysics.[15] In any case, he felt the contradiction between the approaches and the temptation to resolve it by appeal to a higher science. He notes, however, that scripture says precious little about the nature and number of the spheres and that theology has achieved no settled determination in the matter, the attempt to identify nine spheres corresponding to the number of angelic orders being inconclusive.[16]

Grosseteste has defined the problem most usefully for the present study, since we are concerned with the nature and number of the spheres, especially those 'one or more' other spheres mentioned at the outset of this essay as being beyond the visible stars. On the topic of the numbering of spheres, Sacrobosco's *Sphere* may serve as a point of departure. There are, says Sacrobosco, nine celestial spheres: the eight

visible starry spheres plus the 'last heaven' (*celum ultimum*)[17] or *primum mobile*.[18] He gives no explicit demonstration of the existence of the ninth sphere, but his commentators do. Robert Anglicus, writing in 1271, believed himself to be the first to do so (though in fact he was not). His method combines physics with mathematics in order to reach beyond the limits of the visible:

> …there are nine spheres, yet I have found no sure authority that there should be more than eight either in physics [*scientia naturali*] or mathematics [*mathematica*]. Yet combining physical reasons with mathematical, it seems clear that there should be a ninth sphere…because physics insists that in every genus should be found one first minimum to which all belonging to that genus are reduced. But according to the mathematicians, all eight spheres are moved by a two-fold motion. Therefore it is necessary to posit some celestial body other than those eight which is moved by a simple motion; wherefore there will be a ninth sphere.[19]

Already in about 1230, Michael Scot had reported essentially the same proof, saying that according to mathematicians ('*secundum mathematicos*'), the eighth sphere is moved by a double motion and therefore there will be beyond the eighth sphere another, the ninth, that is moved by a simple motion.[20] Scot separates the mathematical from the physical by adding that the two motions of the eighth sphere are posited by mathematicians, but according to Aristotle and the physicists ('*secundum Aristotelem et secundum naturales*') they are only imaginary or can be made only in imagination *('possibiles sunt fieri in imaginatione sola*').[21] At about the same time as Scot but by a different reasoning, Alexander of Hales was employing other Peripatetic arguments in order to speculate beyond the eighth sphere. He argues that the planetary spheres and the sphere of the fixed stars, which are not uniform in composition or simple in motion, are the cause of generation and corruption here below, and that it is necessary to posit another sphere, uniform and simple, that conserves things in their being.[22]

The point is that Ptolemaic mathematics and Aristotelian physics, singly or in combination, could be applied to the study of the sphere in order to extend knowledge beyond the stars. Once such a move is made, the way is open to speculation on other spheres beyond the ninth, and in the process non-astronomical considerations are usually introduced. The example of Andalò di Negro (ca. 1270-1342) is instructive.[23] The eight

stellar spheres, in his account, are always in one continuous and perpetual motion. Above them is the ninth sphere, called the *primum mobile* because its motion moves all the lower spheres contained within it, and thus there are said to be nine mobile spheres. There must, therefore, be an immobile heaven from which all the lower spheres receive their motion and virtue. Hence it is necessary that we say and confess ('*ut dicamus et confiteamur*') that there is a tenth heaven above the ninth in which are the glory of God and the souls of the blessed, who are not moved or in conturbation but on the contrary are in peace, tranquillity and rest; as Solomon says in the book of Wisdom, the bodies of the blessed are sepulchred in peace.

Andalò slips almost imperceptibly from physical and mathematical considerations into more theological ones, but it was not unusual to sort them out more clearly according to the Aristotelian schema. John Peckham, writing some time before he became Archbishop of Canterbury in 1279, notes that the ethereal region (the region beginning with the sphere of the moon and extending upward) is divided differently according to different considerations.[24] Physicists divide it into eight spheres, because only so many are available to the senses. Mathematicians add a ninth sphere on the basis of 'necessary arguments' and theologians add to that a tenth, suitable for the Court of Heaven. In speaking of physics, Peckham refers to Aristotle, and in speaking of mathematics, he refers to Ptolemy. In his account of theology he refers to 'the aqueous heaven' and 'the works of adornment', ideas associated with commentaries on the six days of creation in Genesis 1.[25] Indeed it is very often the case that when spherists invoke physics, mathematics, and theology, they are thinking of Aristotelian, Ptolemaic, and hexameral ideas respectively. Sometimes, however, theological thinking is referred to Plato, as will be seen in the following paragraphs.

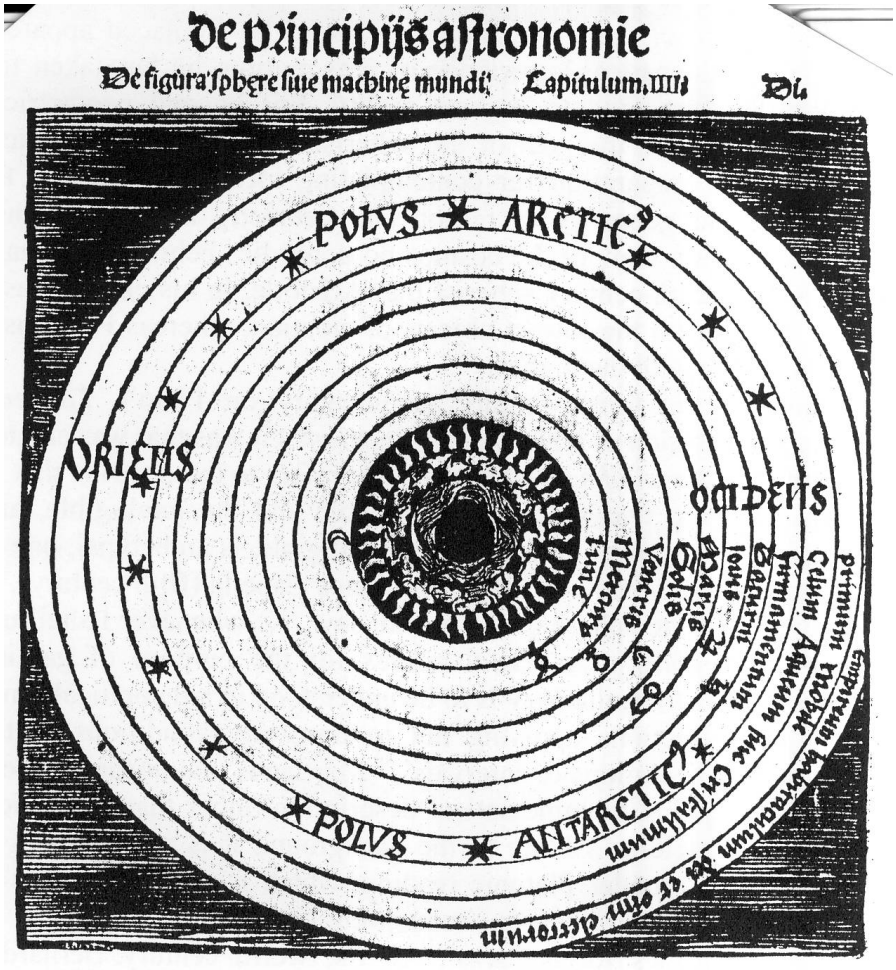
II

Besides the adding of extra-stellar spheres to the composite sphere of the world, there is another way in which theology joined physics and mathematics in a reach toward heaven. That way is through more or less Platonic archetypes or ideas. For most medieval spherists – as for Plato and indeed for Aristotle and Ptolemy as well – there is more to astronomy than simply observing and describing the courses of stars.[26] Observation by the senses yields only appearance. Taking a further step and matching observation with geometrical constructions reveals the permanent

realities underlying the changing phenomena. This is the point of Plato's saying that we gain real knowledge of astronomy only when we pursue it by means of geometrical problems and dispense with the corporeal and visible heavens altogether.[27] Just as the triangle we draw is an imperfect representation of the one we think, so the visible heavens imperfectly represent the 'real' mathematical heavens. The real celestial motions are not the complicated stellar courses one sees; they are the simple and uniform circles that reason makes of courses, by way of forming a geometrical figure of them. When the geometer has replaced apparent motion with mathematical knowledge of real motion, he has taken the first step along the road to highest reality. For beyond geometrical realities lie ideas, and the goal of the spherist in revealing geometrical realities may be preparation for contemplating ideas. Ideas are as far above reason and geometry as reason and geometry are above sense impressions. Such a view of the cosmos no doubt lies behind the remark of an early-thirteenth-century spherist that Aristotle, in his capacity as a physicist, began with the lowest objects of creation, whereas Plato, as a theologian, began with the highest.[28]

Calcidius, in his fourth-century commentary on Plato's *Timaeus*, introduces the question of what heaven ('*caelum*') it was that was created when earth was '*invisibilis et informis*'.[29] He refers to the doctrine that of all things there are two species, the sensible and the intelligible, and concludes that the heaven in question is intelligible, is archetypal, one of the essences, *'exemplaria'*, or ideas. Martianus Capella (fifth century), in his description of the sphere of the world, says, '…whenever I shall use the terms *axis, poles* or *celestial circles* for the purpose of gaining comprehension, my terminology is to be understood in a theoretical sense [*ideali*], the distinctions applying not to transitory conditions in the heavens but to calculations of intervals'.[30] Martianus may mean no more than that he is giving a mathematical description rather than a physical one, but with Calcidius's Plato in the background it is easy enough to give the words a broader Platonic reading, which is what Remegius of Auxerre (ninth century) does in commenting on Martianus. '*Ideali*', he says, 'refers to species, forms, ideas'.[31] By the twelfth century, Bernardus Silvestris can say that the sensible universe ('*sensibilis mundus'*) is born of a better universe ('*mundi melioris'*) and is image ('*imago*').[32] When Bernardus moves beyond the physical and astronomical representation of the sphere, he speaks 'in theological formulation'.[33] He says that the world consists of the earth, the atmosphere, the ether, and the firmament ('*caelum*'), and that beyond the firmament is the dwelling of Turgaton

Figure 1: The finitude and shape of the world from Gregor Reisch, *Margarita philosophica nova*, 1508 (Lilly Library, Indian University, Bloomington).



(Plato's 'Good'), the supreme divinity, surrounded by Seraphim, spirits whose nature is blazing fire.[34] 'Enjoying the vision of eternal bliss, delivered from all the vexations of distracting concerns, they repose in the peace of God which is beyond understanding.[35]

Sacrobosco and his commentator Michael Scot tie this tradition of speculation about heaven firmly to both sphere literature and the division of speculative sciences. Sacrobosco incorporates into his treatise on the sphere three proofs of the sphericity of the universe, based respectively on likeness, convenience, and necessity ('*similitudo', 'commoditas*', and '*necessitas*').[36] The argument from likeness most concerns us here, for it holds that 'the sensible world is made in the likeness of the archetypal world [*mundi architypi*], in which there is neither end nor beginning; wherefore in likeness to it, the sensible world has a round shape, in which beginning and end cannot be distinguished'. Scot explains that the proof derived from necessity is physics, that from convenience is mathematics, and that from likeness is metaphysics or contemplation ('*metaphysica sive theorica'*).[37] On this basis Scot establishes some interesting relations: the physical world ('*mundus sensibilis'*) is to the mathematical world, represented by an instrument such as an armilliary sphere ('*spera materialis'*), as the mathematical world is in likeness to the archetypal world *('ad similitudinem mundi architypi'*).[38] He then quotes the Aristotelian dictum '*abstrahentium non est mendacium*'[38a] in order to assert that, at least with respect to the mathematical and physical worlds, what is demonstrated of the one applies to the other as well.

III

Is abstraction from mathematics to theology the same as abstraction from physics to mathematics? This important and difficult question, when faced directly, tends to be answered in the negative,[39] and we have already seen that Maimonides and Grosseteste are inclined to set limits on how high or far ordinary human knowledge can proceed in the ordinary way of human thinking. Nevertheless, many spherists, regarding the sciences as hierarchically arranged, were tempted to see in them a path ascending toward (if not actually to) a knowledge of heaven,[40] the extramundane sphere of the empyreum that is above or in some sense 'beyond' the stellar spheres. Indeed, it is through a spherist, Martianus Capella, that the term '*empyreum'* as a name for the extramundane world entered medieval usage, to be employed thereafter in commentaries on the six days of creation, where it served to distinguish the heaven of the

first day in Genesis 1:1 (identified with the empyreum) from the heaven of the second day in Genesis 1:8 (the firmament).[41] From Martianus the term passed through the *Glossa ordinaria* (early 12 c.) to the *Sentences* of Peter Lombard (mid-12 c.) and into general scholarly usage.[42]

In Martianus' account of the sphere, the empyreum is already conceived as being beyond the realms of physics and mathematics. After describing Philology's ascent through the planetary orbs, Martianus says that she then:

> beheld the very sphere which contains the outermost periphery, driven on at astonishing speed, and the poles, and the quivering axis which from the highest point of heaven pierces the depth of earth and itself makes the whole mass and fabric of heaven revolve; she was aware that the god who was the father of such a work and so great a system had withdrawn even from the very acquaintance of the gods, for she knew that he had passed beyond the felicity that is itself beyond this world, and he rejoiced in an empyrean realm of pure understanding.[43]

There at the outer periphery she pauses to pray, not to the powers of the sensible world but to deities of the world of pure understanding ('*intellectualis mundi*').[44]

In the *Glossa ordinaria* the empyreum makes its appearance when it is said that the heaven ('*coelum*') of the first day of creation is not the visible firmament but the empyreum - meaning fiery (Greek *pyr* = fire) or intellectual and so called not from its heat but from its splendour - that it was filled with angels from the beginning.[45] From this brief account come several features subsequently attached both to the heaven of the first day and to the empyrean sphere of the spherists: it is called *empyrean*; it is not visible but rather is intellectual (or intelligible[46] or spiritual[47]); it is full of splendour (or lucidity[48]); and it is the abode of angels (and by inference the final abode of the blessed[49]).

Grosseteste's *Hexaëmeron* (ca. 1232-35) reproduces these features and, having in view an image of the sphere of the world, adds two more: namely that the empyreum is at rest and that it is not contained by any other sphere or heaven.[50] Grosseteste thus constitutes a compendious catalogue of features of heaven, one that takes on theological authority through its citations of Jerome, the *Glossa ordinaria* (attributed by Grosseteste and others to Walafrid Strabo), Bede, John Damascene, and Basil: the empyrean heaven is the uncontained, intelligible, lucid, quiet habitation of the blessed.

From hexameral literature the concept of the empyreum fed back into sphere literature, bringing with it an accrual of theological weight, significance, and exclusive authority. The survey of the sphere of the world, for example, in Alan of Lille's *Anticlaudianus* (ca. 1181-84) comes to a crisis at the point of reaching the empyreum.[51] The mysteries there, being beyond the reach of physics and mathematics, cause 'Aristotle to droop and Ptolemy's sense to grow dull'.[52] Only theology[53] can penetrate the empyreum, the extramundane world of light and splendour without heat (5.394-406), the abode of angels and the blessed (5.373-470), and of the Virgin Mary enthroned (5.471-543), a state of peace and rest without labour (5.380).

That philosophers as such knew nothing of the empyreum is often asserted – as by Antonio D'Andres, who is speaking of Aristotle,[54] and by Albert the Great, who is speaking of Ptolemy[55] - and hence writers on the sphere were moved to make up the knowledge deficit by an appeal to Christian theology. On the other hand, since there is no scriptural basis for the doctrine of the empyreum, the conceiving of it is open to the influence of sphere literature. In the thirteenth and fourteenth centuries, what John Murdoch calls a 'two-way street' between natural philosophy and theology[56] was especially busy in the neighbourhood of the ultimate sphere, which could be seen as the immobile sphere of physics and mathematical astronomy and as the empyrean heaven of theology.[57] It became common in these centuries for people writing about the final abode of the blessed to employ principles derived by studying the sphere of the world. Various writers invoke various principles, but all tend to emphasize the themes of uncontainedness, lucidity, intelligibility (i.e., immateriality), and immobility.

IV

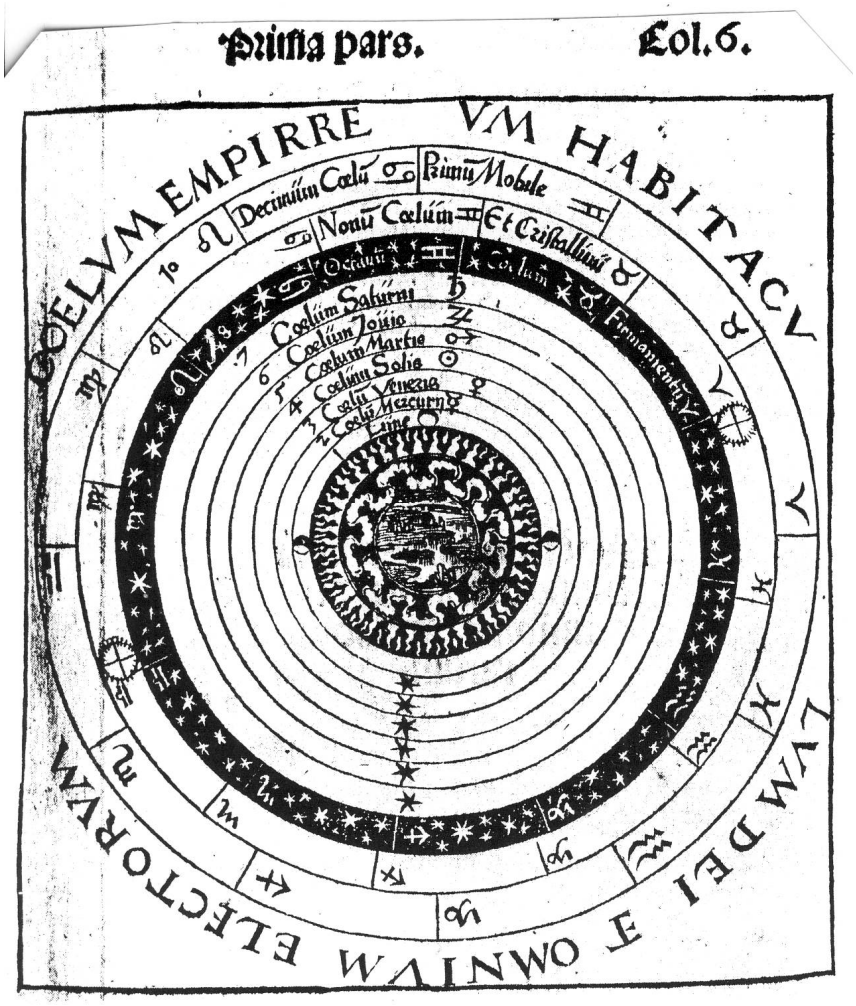
In William of Auvergne's *De universo* (ca. 1231-36), one such principle is the correlation of height (*altitudo*) with subtlety or rarefaction (*subtilitas*) and hence with nobility and spirituality. The framework within which William's scheme fits is given by his contemporary and associate Robert Grosseteste in *De luce*, a cosmogonic account of the way in which light distributes the matter of the cosmos into the form of a sphere so that the centre is dense and opaque and the outer parts rarefied to the extreme ('*ad summum rarefactae'*).[58] *De luce* is physical, mathematical, and metaphysical but not theological in character, there being no references in it to God or the abode of the blessed. For these we

must return to William's *De universo*. In the first part of that work, which is devoted mainly to material nature, William assigns increasing degrees of rarefaction and nobility to each sphere in order from earth upward through the elementary and celestial spheres to the ultimate heaven.[59] In the second part, devoted to the spiritual universe, he argues that as earth is the extreme of materiality and density ('*in ultimitate grossiciei, & corpulentiae*'), the empyreum is the ultimate in thinness ('*in ultimitate parvitatis'*).[60] What is first in altitude, he says, is first also in nobility, subtlety, and spirituality; and therefore the empyreum - the Palace and King's Court of heaven – is fitting for angels and for men when they have been glorified.[61]

In what appears to be an extension of William's argument, the author of the pseudo-Grossetestian *Summa philosophiae* (ca. 1265-75) reasons that as the empyreum is supreme in position, so is it also in nobility; and that furthermore the glorified bodies of the blessed will be higher or lower within the empyreum according to their nobility and the degree to which they are more vivified and therefore more intelligible ('*notiora*' as opposed presumably to more sensible).[62] That the author is basing his argument on data concerning the sphere of the world is emphasized by his assertion that the corporeality and dimensionality of the empyreum are necessary because these accidents are common to all spheres or heavens.[63] That the empyreum can be visualised as disposed spatially in relation to the other spheres is clear from John Peckham's summarising remark that there are four elementary spheres and eleven celestial ones for a total of fifteen from the centre of earth up to the Court of Solomon, i.e. the empyreum ('*ad veri Salomonis regiam – de empyreo dico'*).[64]

It is also clear that the spatial ranking of spheres is associated with a graduated ascent from the materiality and opacity of earth to the intelligibility and lucidity of the empyreum. Indeed, so close is the association that if a writer begins to analyse the sphere on the basis of lucidity rather than spatial disposition, he can nevertheless arrive at much the same results, as is seen in the *Liber de intelligentiis* (ca. 1225).[65] There it is asserted that water possesses more light than does earth (and hence is said to be nobler), air more than water, fire more than air, and the ethereal realm more than all the others. Moreover since light is the simplest and subtlest of bodies, the arrangement of spheres also implies a hierarchy ranged from the grossness of composite earth to the ultimate simplicity and subtlety of the ultimate heaven. The treatise also argues that the ultimate heaven, because of its extreme simplicity, is necessarily

Figure 2: The celestial spheres moving out through the planetary spheres from the moon to Saturn, the fixed stars, primum mobile and the empyreum, from Peter Apian, *Cosmographia liber* (Lilly Library, Indian University, Bloomington).



immobile, and immobility is an important topic that deserves separate treatment.

Immobility is a characteristic so central to the conception of the empyrean sphere that to deny it would be tantamount to denying the existence of the empyreum itself.[66] Having said that, one must add that the spherists seldom discuss the empyreum's immobility in isolation. On the contrary, it is almost inextricably interwoven with the other characteristics of the empyreum and is tied to the physical, mathematical, and metaphysico-theological principles habitually invoked in studies of the sphere of the world. Michael Scot, having described the celestial spheres in terms of Aristotelian physics and in terms of mathematical astronomy,[67] reports in language deriving directly or indirectly from the *Glossa ordinaria* that by theologians ('*a theologis'*) the ultimate sphere is called the empyreum, not from its heat but from its splendour ('*splendore*').[68] He then emphasises that its repleteness with splendour is uniform, for as one is prior to many, uniform to difform or multiform, the simple to the composite, so is it in the nature of the celestial spheres as a class ('*in genere*') that the ultimate one be simple, uniform (without beginning or end), and therefore immobile. Moreover, he says, what participates in nobility without motion is nobler than what so participates with motion.[69] For the author of the *Summa philosophia* the empyreum is not only immobile in itself but is the original principle of rest ('*quietis*') in all natural things.[70] Bernard of Trilia makes the whole distribution of spheres dependent on the relation of motion to completeness or perfection, with the empyrean sphere combining highest perfection with complete immobility.[71] As the place of the blessed, the ultimate, immobile sphere is the noblest of the celestial spheres.

What this immobility means or can mean is that the heavenly abode is characterised by peace and rest. In this matter as in others, John Peckham makes explicit how the conception of the place of heavenly rest relates to the speculative sciences and the sphere of the world. He explains that as the highest of the spheres of the world, the empyreum is immobile ('*fixum et immotum*'); as the Heavenly Court it is the consummation of peace and rest ('*pacis et quietis*'), as is fitting for the felicity of that Court.[72] Peckham, it will be recalled, has said that physics knows eight spheres, mathematics nine, and theology ten. He later adds that the quiescence of the empyreum is seen '*per rationes theologorum*'.[73]

The theme of the uncontainedness of the empyreum is also introduced as evidence of its immobility and, like the topic of immobility, is itself a matter of considerable importance. For inasmuch as the ultimate sphere

that is contained by nothing also contains everything, it constitutes the ultimate place, the fixity by which all motion is measured and grounded.[74] For the spherist, the outer surface of the last sphere is the '*locus universalia*' and '*primus locans*', as Campanus of Novara (ca. 1205-96) calls it in his Tractatus de sphaera.[75] It is, he says in his *Theorica planetarum*, the common and most general place for all things which have position, in that it contains everything and is contained by nothing ('*omnia continens et a nulla alio contenta'*).[76] The requirement that there be a fixed immobility for the cosmos grows naturally from the employment of physics and mathematics in studying the sphere of the world, as the *Summa philosophiae* points out: 'The primum mobile must move on something completely immobile, as physics as well as mathematics makes clear'.[77] That this immobile something should be the empyreum and not 'the centre of the world as Aristotle and other Peripatetics have thought'[78] is a conclusion reached by other considerations. The author explains that the physical or mathematical centre of the world need not be posited as the provider of universal fixity 'once one has admitted the existence of the empyrean heaven containing all other corporeal things and preceding them either in time or in nature'.[79]

The grounds for admitting the existence of the empyrean sphere are stated by Campanus who, although he is writing astronomy, says 'Whether there is anything, such as another sphere, beyond the convex surface of this [ninth] sphere, we cannot know by compulsion of rational argument. However, we are informed by faith, and in agreement with holy teachers of the Church we reverently confess that beyond it is the empyrean heaven in which is the abode of good spirits'.[80] On much the same grounds Dante admits the empyreum. After noting that Aristotle knew only eight heavens and Ptolemy only nine, he says, 'However, outside all these, Catholics place the Empyrean heaven', which is 'luminous', and 'immobile', the abode of the highest Godhead and of the blessed, 'in which all the world is enclosed and beyond which there is nothing'.[81] Campanus and Dante make explicit that knowledge of the empyrean heaven comes from a science higher than physical or mathematical astronomy.

V

In Dante's glancing reference to the nothing that lies beyond the last sphere is a hint of considerations that toward the end of the Middle Ages

tended to separate contemplation of heaven from contemplation of the sphere of the world. In the early fourteenth century, Antonio D'Andres writes that one can find in the universe 'a body that plays the role of place, containing another body but which is in no place, is not contained by any other body; such is the extreme orb or ultimate heaven, whether it is the first mobile, as think the philosophers, or the immobile empyrean heaven, as think theologians, and is the truth'.[82] As a statement about the last sphere as uncontained place and about the superior authority of theology on the topic, this is familiar enough. But D'Andres goes on to say that beyond the abode of the blessed which is the empyrean heaven 'there is no place, no movement, and no time, as said Aristotle in the second book of *De Caelo et Mundo*'. The adducing of this particular assertion from Aristotle suggests how another very large question – that of what, if anything, lies beyond the last sphere – can come into uneasy association with discussions of heaven and the sphere of the world.[83] In Oresme's fourteenth-century French translation of the relevant Aristotelian passage, beyond our world there is 'neither place nor void, nor time', and his gloss says that outside the heavens there is no place, no plenum, and no void ('n'est lieu ne plain ne vieu').[84] The formulation in the gloss also occurs, verbatim, in Oresme's contribution to sphere literature, his *Traité de l'espere*.[85]

What, for a spherist, is the relation of the last heaven to the Aristotelian void? Scot had already dealt with the question in a brief but rather remarkable discussion developed by way of answering certain Aristotelian arguments against the immobility of the last sphere. He first repeats the Hermetic or pseudo-Hermetic definition of God as 'an uncircumscribable sphere whose centre is everywhere and whose circumference is nowhere'.[86] He then connects the immobility of God with the immobility of the sphere that is the place of God. Consideration of God as an infinite sphere leads to the conclusion that because the heavenly sphere is not moved from place to place, both God and the place of God are immobile.[87] Are, then, both God and the place of God also infinite? Nicholas of Cusa is famous for having in the fifteenth century transferred the metaphor of the infinite sphere from God to the universe, but the transfer is already implicit in the thirteenth century, in Scot's God-sphere, which is uncontained and uncontaining, alpha and omega, beginning and end,[88] immobile because it has literally no place to go.

Though Scot thus attaches the idea of the infinite sphere to the *sphaera mundi* and in so doing brings in the topic of infinite void space, that topic is generally separate from sphere literature proper. Medieval treatments

of 'God-filled extramundane infinite void space' are indigenous to neither sphere literature nor hexameral literature; rather they are direct responses to Aristotle's claim that the universe is one, solitary, and complete and that beyond it there is nothing.[89] Hence we find Oresme treating the void extensively in his translation of and commentary on *De Caelo*. But in his *Traité de l'espere* - which is a sphere-treatise and updating of sphere-treatises by Sacrobosco, Grosseteste, and others[90] - he avoids the topic and limits his speculations much more narrowly.

Because the *Traité* glances backward to earlier *sphaerae* and is in the same genre, it considers the traditional application of the speculative sciences to the sphere, but in doing so it insists upon a very different understanding of their applicability. Speaking as a physicist, Oresme describes the seven planetary spheres and the sphere of the fixed stars.[91] Then he says 'according to mathematical astronomers, above all of these is the ninth sphere in which no star appears'. This much we have come to expect from spherists. We also expect that at this point Oresme will explain what theology can contribute to the study of the sphere, but he writes instead, 'Then some say that above it [i.e., the ninth sphere] there is an immobile heaven, then a heaven of crystal, and then the empyrean heaven in which is the throne of Solomon, and such things as pertain to neither physics nor astronomy. Therefore it will be sufficient for us to speak only of the nine spheres mentioned above'.

Oresme has, I think, seen and confirmed the end of the developments noticed in the present essay: developments in the conception of heaven as influenced by the study of the old model of the sphere according to a conventional division (or linkage) of sciences. The highest of the speculative sciences – the theological/metaphysical – has been effectively banished from the study of the sphere. That banishment, even more than the changes in the model of the sphere that would occur and were already occurring, put an end to the long tradition of systematic and continuous attempts to reach an understanding of heaven through the *sphaera mundi*. As the leading nominalist in the generation between William of Ockham (d. 1349) and Jean Gerson (d. 1429), Oresme was pivotal in a turning of thought that, in reaction to what some came to regard as vain curiosity, produced a call for acknowledgement of the limits of each discipline.[92] Thinkers who participated in that turning, says Heiko Oberman, 'discovered "space" by transforming the metacosm from the "heavenly abode" of God into an infinite extension of the macrocosm'.[93] The idea of an infinite sphere, which Scot had transferred from God to the cosmos implicitly and quasi-metaphorically, had now been transferred explicitly

and literally and carried a consciousness of the limitations on what could be learned from its study. The very act by which Oresme dismisses theology from the study of the sphere is a decisive instance of a more general change Oberman describes when he says, 'After the elimination of the metacosmos as sheer speculation, all attention is given to natural laws grafted by God into his creation'.[94] The sphere was no longer seen as an object of theological study.

The sphere of the world, in its long history, did much to shape, focus, and give its special emphases to medieval conceptions of heaven. But in the end it seems to have taken on too much imaginative solidity to be of further use in intellectual efforts to know heaven. It became a thing no sooner thought of than visualised, an instance perhaps of what Huizinga characterises as 'thought crystallising into image'.[95] Boethius had noted that in physics we must think scientifically, in mathematics systematically, and in theology intellectually; and he had warned that 'in Theology we should not be diverted to play with imaginations, but rather apprehend that form which is pure form and no image…'[96] The sphere, insofar as it was a product of the imaginative faculty, was too closely tied to sensible perception of the physical world. It was against that world that it came to be tested, modified, and finally, to borrow C.S. Lewis's word, 'discarded'.[97] The study of heaven, meanwhile, would have to proceed along different paths.

References

1. The conception appears to go back to the First Babylonian Dynasty. See Willy Hartner, *Oriens-Occidens* (Hildesheim, 1968), pp. 266-67, repr. from *Encyclopedia of Islam*, new ed. (Leiden, 1960-), s.v. 'falak'; also Otto Neugebauer, *The Exact Sciences in Antiquity* (Providence, 1952), p. 199; and Bernard Goldstein, 'The Status of Models in Ancient and Medieval Astronomy', *Centaurus* 24 (1980), 134.

2. Thomas Heath, *Aristarchus of Samos* (Oxford, 1913; repr. 1959), pp. 317-320.

3. Lynn Thorndike, ed., *The 'Sphere' of Sacrobosco and Its Commentators* (Chicago, 1949). Jefferson's copy was printed in Venice in 1485.

4. Sphaerae as constituting an antique and medieval genre are described by Heath, *Aristarchus*, pp. 317-320, and by S.J. Tester, *A History of Western Astrology* (New York, 1987), pp. 30-32, 113, 125, 145, 150, 187.

5. The division, from *Metaphysics* 6.1, was transmitted to the early Middle Ages through Boethius (See J.A. Weisheipl, 'Classification of Sciences in Medieval Thought', *Mediaeval Studies* 27 [1965], 54-90). The third science is variously named. Boethius, *De Trinitate* (quoted below) calls it 'theologia'. Dominicus Gundissalinus, elaborating on Boethius in *De divisione philosphiae* (ed. Ludwig Baur, Beiträge zur Geschichte der Philosophie des Mittelalters, 4, nos. 2-3 [Munich, 1903], 15), provides synonyms: 'tercia dicitur theologia siue sciencia prima, sine philosophia prima, sine metaphysica'. Thomas Aquinas (as cited below, note 7), commenting on Boethius, distinguishes between 'metaphysica' (Avicennan, as used here) and 'theologia', 'but he applies both terms to the third Aristotelean science. On the developing term and concept *theology*, see Paul Vignaux, *Philosophy in the Middle Ages*, trans. E.C. Hall (New York: Meridian Books, 1959), pp. 56-59.

6. *De nuptiis Philologiae et Mercurii* 8.814, ed. Adolf Dick (Leipzig, 1925), 431. Martianus speaks through Astronomy (Ouranos), who cites Eratosthenes, Ptolemy, and Hipparchus (8.813).

7. *In librum Boetii De Trinitate*, *Expositio* in *Opera omnia secundum impressione Petri Fiaccadori Parmae* (New York, 1950) 17: 362. Cf. Avicenna, *Metaphysics* 1.3, ed. S. van Riet, *Avicenna Latinus: Liber de philosophia prima sive scientia divina* (Louvain, 1977), p. 21: '…multa de his quae concenduntur in ista sunt de illis quae iam probata sunt in naturali…'

8. *De Trinitate*, ed. and trans. H.F. Steward, E.K. Rand, and S.J. Tester, *Boethius*, Loeb Classical Library (Cambridge, Mass., 1973), pp. 8-9, my paragraph indentations.

9. *Le Système du monde* (Paris, 1913-59). The theme recurs throughout but is made explicit in vol. 2, chaps. 10-11, and vol. 4, chaps. 8-9. Se also George Sarton, *Introduction to the History of Science* (Washington, 1927-48), vol. 1, pt. I, pp. 16-19; E.J. Dijksterhuis, *The Mechanization of the World Picture*, trans. C. Dikshoorn (Oxford, 1961), pp. 209-216; David C. Lindberg, *The Beginnings of Western Science* (Chicago, 1992), pp. 261-63.

10. In Thorndike, *Sphere* p. 148.

11. Emmanuel Poulle, *Les Instruments de la théorie des planètes selon Ptolémée* (Geneva, 1980) 1:6.

12. *Guide of the Perplexed* 2. 3, trans. Schlomo Pines (Chicago, 1963), 326.

13. Ibid. The quotation is from Psalms 115:16.

14. Lindberg, *Beginnings*, pp. 261-63, argues that the physical and mathematical approaches are distinguished less on methodological grounds than according to textual traditions, the one stemming from Aristotle and the other from Ptolemy.

15. Duhem, *Système* 3: 397-98.

16. *Hexaëmeron* 3.8.1, ed. Richard C. Dales and Servus Gieben (London, 1982), p. 108: '…in universo sint novem celi: septem videlicit celi septem planetarum, et celum stellatum, et celum aplanon; ex quorum numero quidam credunt se probare numerum ordinum angelicorum' ('there are nine heavens in the universe: viz. seven heavens of the seven planets, together with the heaven of the stars and the heaven at rest [Gk. Aplanes = fixed]; from their number some people believe they can demonstrate/represent/prove the number of angelic ranks.)

17. In Thorndike, *Sphere* p. 79.

18. Ibid., p. 86.

19. Ibid., p. 148.

20. Ibid., p. 260.

21. Ibid., p. 278.

22. Quoted in French translation by Duhem, *Système* 3:402, from the *Summa theologica* of Alexander or his school.

23. In Thorndike, *Sphere*, p. 464.

24. Ibid., pp. 447-48.

25. Relevant materials on the six days are conveniently collected in volume 10 of the Blackfriars edition of Aquinas' *Summa theologiae*, ed. and trans. by William Wallace (New York, 1967), Appendices 7-9. See also Nicholas Steneck, *Science and Creation in the Middle Ages* (Notre Dame, 1976), pp. 18-22, and Edward Grant, 'Science and Theology in the Middle Ages', in *God and Nature: Historical Essays on the Encounter between Christianity and Science*, ed. David C. Lindberg and Ronald L. Numbers (Berkeley, 1986), pp. 59-64.

26. On this point with respect to Plato and Aristotle, see Duhem, *Système* 2:70; with respect to Ptolemy, see *Almagest* 1.1.

27. *Republic* 7. 529a-530b, and see Heath, *Aristarchus*, pp. 135-38.

28. 'Nicholas the Peripatician', tentatively identified with Michael Scot and quoted, in French, by Duhem, *Système* 3:245.

29. *Timaeus a Calcidio translatus commentarioque instructus*, ed. J.H. Waszink (London, 1962), pp. 282-83.

30. *De nuptiis* 8.816, ed. Dick, p. 432.

31. *Remigii Autissiodorensis commentum in Martianum Capellam*, ed. Cora E. Lutz (Leiden, 1965), p. 254.

32. *Cosmographia* 2.10, ed. Peter Dronke (Leiden, 1978), p. 140.

33. *Cosmographia* 2. 5, ed. Dronke, 127-28; trans. Winthrop Wetherbee (New York, 1973), p. 98.

34. *Cosmographia* 2.7. Wetherbee, trans. *Cosmographia*, p. 160, note 45, identifies these fiery spirits with Seraphim.

35. Ibid., trans. Wetherbee, p. 107.

36. In Thorndike, *Sphere*, p. 80.

37. Ibid., p. 286. The use of *theorica* here is odd but not unprecedented. Olaf Pederson says that '*theoricus* entered Medieval Latin as a word with definitely theological connections' ('Theorica: A Study in Language and Civilisation', *Classica et Mediaevalia* 22 [1961]: 153).

38. In Thorndike, *Sphere*, pp. 248-49.

38a. 'The objects of mathematics, though in fact inseparable from physical, moveable body, are studied in abstraction from movement and this *abstraction involves no error*'; Sir David Ross, *Aristotle*, London, Methuen and Co., 1974, p 68.

39. E.G., by Dominicus Gundissalinus, *De divisione philosophiae*, ed. Baur, p. 42; and, after considerable struggle, by Aquinas *In lib. Bo. De Trin*. q.5, a.3. See L.B. Geiger, 'Abstraction et séparation d'après S. Thomas', *Revue des sciences philosophique et théologique* 31 (1947): 3-40.

40. Weisheipl, 'Classification of Sciences', esp. pp. 72, 79, 87, 89, describes a tradition alternative to the 'authentically Aristotelian' one represented by Albert the Great and Aquinas, in which alternative 'each science is resolved into a

higher and more universal science'. The spherist Robertus Anglicus, citing Ptolemy, says astronomy 'is, as it were, a road leading to God'. (Thorndike, *Sphere*, p. 199). Also, see note 16, above.

41. See note 25, above.

42. Francis S. Benjamin and G.J. Toomer, ed. and trans., *Campanus of Novara and Medieval Planetary Theory* (Madison, 1971), p. 393. Martianus' empyreum is given as an example of dogma engendered anciently from metaphor and etymology (*en* 'in' plus *pyr* 'fire') by A. Bouche-Leclerq, *L'Astrologie Grecque* (Paris, 1899, repr. 1963), p. 23. References to the empyreum are collected by Thomas Litt, *Les Corps célestes dans l'univers de saint Thomas d'Aquin* (Louvain, 1963), pp. 255-61.

43. *De nuptiis* 2.200-202, trans. W.H. Stahl, *Martianus Capella and the Seven Liberal Arts* (New York, 1977) 2:60-61.

44. Ibid.

45. 'Coelum, non visible firmamentum, sed empyreum, id est, igneum vel intellectuale, quod non ab ardore, sed a splendore dicitur, quod statim repletum est angelis' (PL 113:68).

46. Grosseteste, *Hexaëmeron* 1.16, ed. Dales and Gieben, p. 173: '*in intellectu*, id est intelligibiles, scilicet empireum'.

47. Dante Alighieri, *Epistle* 13.24 in *Tutti le Opere*, Editione del Centenario (Milan, 1965), p. 866: 'Et dicitur empyreum…non quod in eo sit ignis vel ardor materialis, sed spiritualis, quod est amor sanctus sive caritas'.

48. Thomas Aquinas, *Summa theologiae*, 1a. 66, 3: 'totaliter lucidum'.

49. Aquinas, ibid., citing Basil.

50. 1.16, ed. Dales and Gieben, pp. 73-75. Grosseteste's decision to include these not-unprecedented details (they are in Martianus) is influenced by Aristotle's *De caelo et mundi,* which Grosseteste adduces and names.

51. A.J. Minnis and A.B. Scott, *Medieval Literary Theory and Criticism: The Commentary Tradition* (Oxford, rev. ed., 1991), p. 125, say that the climax of the *Anticlaudianus* is 'clearly influenced by Dionysian negative theology' and compare the fainting of Prudence at that point, entering the realm of joy and light, with the 'lethargy and rapture of the Dante-persona's mind' in *Paradiso* 33. 90-94.

52. 5.372, ed. R. Bossuat (Paris, 1955), p. 34; trans. James J. Sheridan (Toronto, 1973), p. 150.

53. Called 'regina poli' by Alan, 5.178, and identified as 'the maiden Theology' by Sheridan, trans., *Anticlaudianus*, p. 139; and as Theology or Divine Intelligence or both by Bossuat, ed., *Anticlaudianus*, p. 28.

54. Quoted by Pierre Duhem, *Medieval Cosmology*, ed. and trans. Roger Ariew (Chicago, 1985), p. 205.

55. Duhem, *Système* 3:338.

56. 'The Analytic Character of Late Medieval Learning: Natural Philosophy without Nature', in Lawrence D. Roberts, ed., *Approaches to Nature in the Middle Ages*, Medieval and Renaissance Texts and Studies, vol. 16 (Binghamtpon, New York, 1982), p. 173. Grant, 'Science and Theology', p. 60 and note 32, reports that the 'injection of science, mathematics, and logic into commentaries on Peter Lombard's *Sentences* grew to such proportions that in 1366 the University of Paris declared that except where necessary those who read the *Sentences* should avoid the introduction of logical or philosophical material into the questions'. He quotes a complaint that from the early fourteenth century, 'theologians have not feared to work into their writings questions which are purely physical, metaphysical, and sometimes purely mathematical'.

57. Duhem, *Medieval Cosmology*, p. 145, points out that between *caelum* as the abode of the blessed and *caelum* as the ultimate sphere of the spherists there is an equivocation. He quotes Roger Bacon's remark in his *Questions* on Aristotle's *Physics* that 'what we prove about heaven, we are intending to prove about the ultimate sphere'.

58. In Ludwig Baur, ed., *Die philosophischen Werke des Robert Grosseteste, Bischofs von Lincoln*, Beiträge zur Geschichte der Philosophie des Mittelalters, 9 (Munich, 1912), pp. 51-59, esp. 54.

59. *De universo* 1.44, in *Opera omnia* (Venice, 1591), p. 612.

60. Ibid. (2.78), p. 878.

61. Ibid. (2.78), pp. 877-78. Cf. the argument of Alexander of Hales (d. 1245) that, given the necessary completeness of the universe, as in earth extreme opacity exists, so must extreme lucidity exist in the empyreum (Duhem, *Système* 3:403).

62.15.3, in Baur's edition of Grosseteste (see note 58, above), pp. 545-46.

63. Ibid., p. 546. Cf. Dante, *Paradiso* 4. 19-42, wherein the apparent distribution of souls among planetary spheres is said to be a concession to sensible perception and an indication of their real places in the empyreum. On Dante's empyreum, see M.A. Orr, *Dante and the Early Astronomers* (London, rev. ed. 1956) – see index under 'empyreum'; and Paget Toynbee, *A Dictionary of Proper Names and Notable Matters in the Works of Dante*, rev. ed. by Charles S. Singleton (Oxford, 1968), s.v. 'Cielo empyreo'.

64. In Thorndike, *Sphere*, p. 448. An early fourteenth-century manuscript of Peckham's treatise on the sphere contains a depiction of the sphere of the world with Solomon enthroned in the empyreum. It is reproduced by John Murdoch, *Album of Science* (New York, 1984), p. 335. Nicholas of Lyra (d. 1349) interprets 1 Chronicles 17:13 ('I will be a father to him and he shall be my son') as referring literally to both Solomon and Christ (Minnis and Scott, *Medieval Literary Theory*, p. 206).

65. The treatise, formerly ascribed to Witelo and now thought to be by Adam Pulchrae Mulieris, is printed by Egidio Guidubaldi, *Dal 'De luce' di R. Grossatesta all'islamico 'Libro della Scala*', *Testi medieval di interesse dantesco*, vol. 2 (Florence, 1978), pp. 103-160. The sections here paraphrased are 8.2 and 8.4. Guidubaldi connects the tradition of the empyreum's lucidity with Dante's eternal light in *Paradiso* 34.

66. This is so even though there are Aristotelian grounds for denying the last sphere's immobility, as do Jean Buridan (d. after 1358) and Albert of Saxony (d. 1390). See Edward Grant, *Planets, Stars, and Orbs: The Medieval Cosmos*, 1200-1687 (Cambridge, 1994), pp. 95, 374-78.

67. In Thorndike, *Sphere,* p. 281: 'secondum Aristotelem', p. 282: 'secundum omnes astrologos'.

68. Ibid., p. 283.

69. Cf. Thomas Aquinas, *Quodlibetal Questions*, as reported by Grant, *Planets*, p. 380: 'Thomas employs a hierarchy of descending perfections based on rest as the most perfect'. Thomas's fullest account of the empyreum is in *Summa theologiae*, Ia. 66, 3, where it is presented in a cosmological context and is characterised as the place of the blessed (*locus beatorum*) and of rest (*quietis*, quoting Basil), full of light (*totaliter lucidum*).

70. In Baur, *Philosophischen Werke*, p. 546.

71. Commentary (ca. 1263-66) on Sacrobosco's *Sphere*, quoted by Duhem, *Système* 3: 376-78.

72. In Thorndike, *Sphere*, p. 448. Cf. Thomas of Strasbourg (fl. 1345), paraphrased by Grant, *Planets,* p. 373: 'Immobility is the only appropriate state for the blessed, who are themselves in a perfect state of rest'.

73. In Thorndike, *Sphere*, p. 450.

74. 'Place' (*locus*) in the sense of 'the immobile surface of the circumambient medium' is a very large topic in medieval physics. Many discussions of it scattered through several volumes of Duhem's *Système* are collected in Duhem, *Medieval Cosmology*, pp. 139-291. See also Grant, *Planets*, pp. 122-35.

75. Benjamin and Toomer, *Campanus of Novara*, p. 394, note 55.

76. Ibid., p. 182. Duhem points out (*Medieval Cosmology*, p. 175) that Campanus is echoing St. Bonaventure almost verbatim. Campanus in turn is echoed, more or less, in Dante's and Chaucer's references to the Holy Trinity: 'non circunscritto, e tutto circunscrive' (*Paradiso* 14.30) and 'Uncircumscript, and al maist circumscrive' (*Troilus and Criseyde* 5. 1865). Further conflation of God with the uncontained sphere is noticed below.

77. In Baur, ed., *Philosophischen Werke*, p. 546.

78. Ibid.

79. Ibid. Knowledge of the empyreum was taken to represent an advance made possible by Christian theology. Antonio D'Andres, discussing Aristotelian 'place' in a passage quoted in Duhem, *Medieval Cosmology*, p. 205, says, 'Here I am not referring to the immobile empyrean heaven, for Aristotle did not know of it'.

80. Benjamin and Toomer, *Campanus of Novara*, p. 183.

81. Convivio 2.3-4.

82. From *Questions on the Six Principles* of Gilbertus Porretanus, quoted in Duhem, *Medieval Cosmology*, p. 204. Duhem says that through the influence of Roger Bacon this question had become a common one among the Franciscans.

83. For the passage in question, which is also cited in Grosseteste's *Hexaëmeron* (see note 50, above), see Aristotle, *On the Heavens* 1.9, trans. W.K.C. Guthrie (Cambridge, Mass., 1986), p. 91. On the extensive medieval discussion of the

'extracosmic void', see Duhem, *Medieval Cosmology*, pp. 369-427; Edward Grant, ed., *A Source Book of Medieval Science* (Cambridge, Mass., 1974), pp. 554-68 (translated medieval texts); and Edward Grant, *Much Ado About Nothing: Theories of Space and Vacuum from the Middle Ages to the Seventeenth Century* (Cambridge, 1981).

84. *Le Livre du ciel et du monde*, ed. and trans. Albert D. Menut and Alexander J. Denomy (Madison, 1968), p. 160.

85. Oxford, St. John's College MS 164, fol. 4r: 'ne corps, lieu, plain, ne vuit, selonc ce que dit Aristote'.

86. In Thorndike, *Sphere*, p. 280: '…deus… est spera incircumscriptibilis cuius centrum est ubique, circumferentia vero nusquam…' Cf. the earliest known version of the definition, from the *Liber XXIV philosophorum*, definition 2, ed. Francoise Hudry for Collection Krisis (Brignoud, 1989), p. 93: 'Deus est sphaera infinita, cuius centrum est ubique, circumferentia nusquam'; also the variation in Alan of Lille, *Regulae theologicae*: 'Deus est sphaera *intelligibilis*, cuius centrum ubique, circumferentia nusquam' (emphasis added).

87. In Thorndike, *Sphere,* p. 280: '…quia celum non movetur de loco ad locum, ideo deus est immobilis, ita est locus dei'.

88. Ibid. In 'The Infinite Sphere: Comments on the History of a Metaphor', *Journal of the History of Philosophy* 13 (1975): 6ff, Karsten Harries argues that the transfer 'is suggested by the metaphor itself. The metaphor of the infinite sphere presupposes an understanding of God and man which had to lead men beyond the medieval cosmos'.

89. Grant, *Source Book*, p. 555. The relevant Aristotelian text is, again, *De caelo* 1.9.

90. Throughout his own treatise on the sphere, Oresme refers frequently to the sphere treatises of Sacrobosco ('l'aucteur de l'espere') and Grosseteste ('Lincolniense').

91. Fol. 3r in the St. John's manuscript.

92. 'Reformation and Revolution: Copernicus' Discovery in an Era of Change', in John E. Murdoch and Edith D. Sylla, eds., *The Cultural Context of Medieval Learning*, Boston Studies in the History of Science, vol. 26 (Dodrecht, Holland, 1975), 406.

93. Ibid., p. 410. *Metacosm* (for the realm of God) is a modern term coined to go with *microcosm* (for man) and *macrocosm* (for the universe). It is the medieval *mundus archetypus* or *intelligibilis* or *melioris*. Between it and man the universe is sometimes seen as interpolated (Rudolf Allers, 'Microcosmus: From Anaximandros to Paracelsus', *Traditio* 2 [1944]: 350-51).

94. 'Reformation and Revolution', p. 410. Sheila Delany, 'Undoing the Substantial Connection: The Late Medieval Attack on Analogical Thought', *Mosaic* 5 (1972): 31-52, argues that Oresme's philosophical nominalism and the scientific assumptions and practices connected with it are not causative but are items in a larger cultural change, with roots in economics and class structure, that also shows itself in literature and political theory.

95. J. Huizinga, *The Waning of the Middle Ages* (London, 1924, repr. 1952), pp. 136-59.

96. *De Trinitate* 2 (Loeb, p. 9).

97. C.S. Lewis, *The Discarded Image* (Cambridge, England, 1964).